

APPENDIX B

Sampling and Analysis Plan

TITLE AND APPROVAL PAGE

This Sampling and Analysis Plan (SAP) describes requirements for the site remedial activities at the NASA JPL Facility.

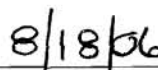
Title of the Project: OUI Remedial Design (RD)/Remedial Action (RA) Work Plan.

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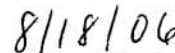
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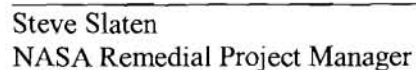
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ACRONYMS AND ABBREVIATIONS

| | |
|-------------------------------|---|
| AL | action level |
| amsl | above mean sea level |
| bgs | below ground surface |
| CFR | Code of Federal Regulations |
| CCL ₄ | carbon tetrachloride |
| ClO ₄ ⁻ | perchlorate |
| CPR | cardiopulmonary resuscitation |
| DHS | Department of Health Services |
| DI | distilled |
| DO | dissolved oxygen |
| DOT | Department of Transportation |
| DQO | data quality objective |
| FBR | fluidized bed reactor |
| FEP | fluorinated ethylene polymer |
| FID | flame ionization detector |
| GAC | granulated activated carbon |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HCl | hydrochloric acid |
| HPLC | high-performance liquid chromatography |
| I.D. | inside diameter |
| IDW | investigation-derived waste |
| LCS | laboratory control spike(s) |
| LCSD | laboratory control spike duplicate(s) |
| LQAP | Laboratory Quality Assurance Plan |
| MCL | maximum contaminant level |
| MDL | method detection limit |
| MS | matrix spike(s) |
| MSD | matrix spike duplicate(s) |
| NA | not applicable |
| ND | not detected |
| NEDD | Navy Environmental Data Deliverable |
| NFESC | Naval Facilities Engineering Service Center |
| O ₂ | oxygen |
| O&M | operation and maintenance |
| ORP | oxidation-reduction potential |
| OSHA | Occupational Safety and Health Administration |
| PPE | personal protective equipment |

| | |
|----------|---|
| QA | quality assurance |
| QAO | Quality Assurance Officer |
| QAPP | Quality Assurance Project Plan |
| QA/QC | quality assurance/quality control |
| QC | quality control |
| RA | remedial action |
| RD | remedial design |
| RPD | relative percent difference |
| RPM | Remedial Project Manager |
| RSD | relative standard deviation |
| SAP | Sampling and Analysis Plan |
| U.S. EPA | United States Environmental Protection Agency |
| VOA | volatile organic analysis |
| VOC | volatile organic compound |

1.0 PROJECT MANAGEMENT

This Sampling and Analysis Plan (SAP) has been provided as Appendix C in the OU1 Remedial Design (RD)/Remedial Action (RA) Work Plan for the NASA JPL facility. The SAP serves two functions: (1) identifying the data to be collected and the methods of sample collection and analysis; and, (2) documenting how quality assurance (QA) and quality control (QC) activities will be implemented during the life cycle of the project to ensure that data are of sufficient quality for their intended purpose (i.e., to support decision making regarding remediation of the groundwater beneath NASA JPL). The SAP was prepared according to United States Environmental Protection Agency (U.S. EPA) Guidance (EPA QA/R-5; U.S. EPA, 2001) on preparation of Quality Assurance Project Plans (QAPPs); according to the U.S. EPA guidance, QAPPs are designed to be stand-alone documents that describe both field sampling activities as well as quality assurance/quality control (QA/QC) activities.

The information presented in this SAP is organized into four groups according to their function as follows:

- A. Project Management – this group is divided into elements that describe general areas of project management, project history and objectives, and roles and responsibilities of the participants.
- B. Data Generation and Acquisition – this group is divided into elements that describe the existing (Demonstration System) and proposed (Expanded Demonstration System) design, sampling and analytical methods, sample handling, and QC requirements.
- C. Assessment and Oversight – this group is divided into elements that describe activities for assessing the effectiveness of sample collection and analysis and associated QA/QC requirements.
- D. Data Validation and Usability – this group is divided into elements that describe QA activities that occur after the data generation and acquisition phase of the project has been completed to ensure that data conform to the specified criteria and thus are useful for their intended purpose.

1.1 Title and Approval Page (A1)

The NASA JPL SAP Project Title and Approval sheet is provided as page ii of the SAP.

1.2 Table of Contents (A2)

The NASA JPL SAP Table of Contents is presented beginning on page iv of the SAP.

1.3 Distribution List (A3)

The NASA JPL SAP Distribution List is presented on page iii of the SAP.

1.4 Project Organization and Responsibilities (A4)

Figure B-1 provides a project organization chart for RD/RA at the NASA JPL facility. Key personnel shown in the chart include the NASA Remedial Project Manager (RPM), NAVFAC Coordinator, JPL Point of Contact, Battelle Project Manager, Battelle Quality Assurance Officer (QAO), and the Battelle Project Team. Key subcontracted services are anticipated to include the following: analytical laboratories

for analysis of soil and water samples; driller for installation of wells and collection of soil samples; and surveyors for site layout. Key roles and responsibilities for technical staff associated with the work outlined in this SAP are presented in the Distribution List, which includes contact e-mail addresses and telephone numbers for staff members.

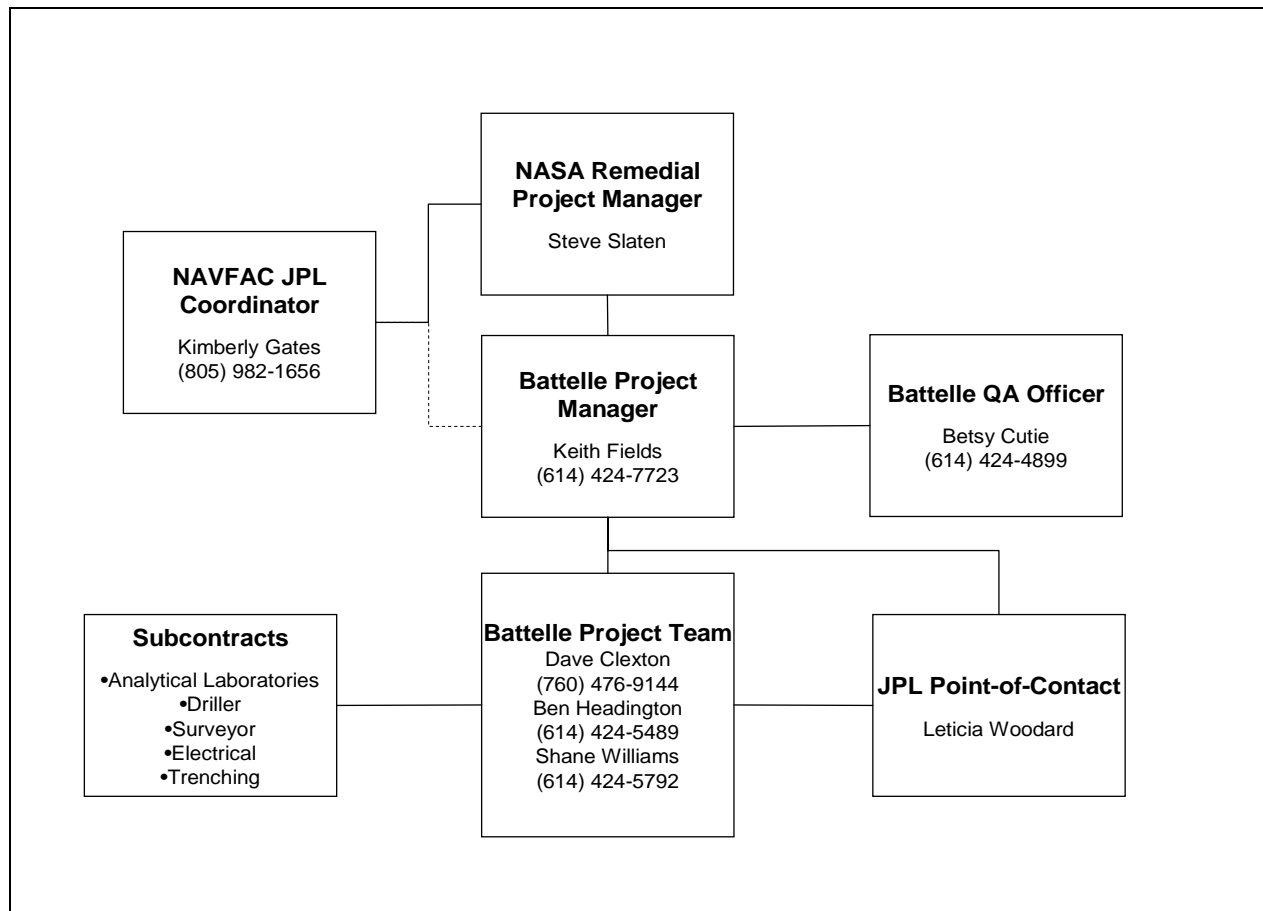


FIGURE B-1. PROJECT ORGANIZATION CHART FOR EXPANDED DEMONSTRATION SYSTEM INTERIM ACTION AT THE NASA JPL FACILITY

1.5 Problem Definition/Background (A5)

Perchlorate (ClO_4^-) and carbon tetrachloride (CCl_4), which are believed to be associated with historic waste management practices at NASA JPL, have been detected in water supply wells located downgradient of the NASA JPL facility. Significant dissolved phase concentrations of ClO_4^- and CCl_4 (greater than 100 times California Action Level [AL] and Maximum Contaminant Level [MCL], respectively) are located on the NASA JPL facility and likely serve as a continuing source. The presence of a continuing source is supported by elevated concentrations in the suspected release area over 40 years after the discharge(s) occurred. The highest dissolved phase concentrations of ClO_4^- and CCl_4 are collocated in the uppermost hydrostratigraphic layer near MW-7, MW-16, and MW-24.

The Expanded Demonstration System, interim action will extend the effectiveness of the expanded treatability study (Demonstration System) by broadening the treatment area in a westerly direction to

further target the suspected source area, which has been defined as an 8-acre by 100-ft-thick portion of the site, located in the north-central section of the NASA JPL facility. This source area is located entirely within the OU-1 boundaries and is estimated to contain over 68% of the dissolved phase perchlorate mass in groundwater at the site. The removal of perchlorate from groundwater beneath the facility will decrease the up-gradient source term and potentially reduce the duration of the proposed removal action of wellhead treatment for Operable Unit 3 (OU-3).

1.6 Project/Task Description (A6)

The Expanded Demonstration System remedial approaches identified for implementation include the addition of an extraction well and pump and an injection well, which will be merged with the existing Demonstration System treatment system. Expanded Demonstration System will increase the effectiveness of the Demonstration System system by increasing the groundwater treatment flow rate from 150 gpm to a maximum flow rate of 350 gpm, thereby increasing the treatment area. Expanded Demonstration System will utilize the Demonstration System groundwater treatment system, which includes aboveground granular activated carbon (GAC) adsorption, fluidized bed reactor (FBR) treatment, trimite filtration, and groundwater reinjection. The project objectives are as follows:

- Extend the overall effectiveness of the OU-1 treatment system.
- Expedite chemical mass reduction in the OU-1 area.
- Design a flexible system design that will be the final remedial action for OU-1.

1.7 Quality Objectives and Criteria for Measurement Data (A7)

This section presents the quality objectives for the project and the performance criteria necessary to meet these objectives. Included are discussions of the project data quality objectives (DQOs), the quantitative DQOs (precision, accuracy, and completeness), and the qualitative DQOs (comparability and representativeness). The overall QA objective is to generate data that are of known, documented, and defensible quality.

1.7.1 Data Quality Objectives

DQOs are statements that specify the quantity and quality of the data required to support project decisions. DQOs for this project were developed using the seven-step process *Guidance for the Data Quality Objectives Process* (U.S. EPA, 2000). The DQOs are presented in Table B-1. The QA procedures as well as the associated field sampling procedures contained in this SAP are focused on achieving these DQOs in a timely, cost-effective, and safe manner. Deviations from these objectives will require defining the cause or causes for noncompliance and will initiate the process of determining whether additional sampling and analyses will be required to attain project goals.

1.7.2 Quantitative Objectives: Precision, Accuracy, and Completeness

Precision quantifies the repeatability of a given measurement. Precision is estimated by calculating the relative percent difference (RPD) of laboratory and field duplicates, as shown in Equation (B-1).

$$\text{RPD (\%)} = \frac{|\text{Original} - \text{Duplicate}|}{(\text{Original} + \text{Duplicate})/2} \times 100 \quad (\text{B-1})$$

Table B-1. Data Quality Objective Steps for Assessment of Contaminated Soil and Groundwater

| STEP 1 State the Problem | STEP 2 Identify the Decision(s) | STEP 3 Identify the Inputs to the Decisions | STEP 4 Define Study Boundaries | STEP 5 Develop Decision Rules | STEP 6 Specify Tolerable Limits on Errors | STEP 7 Optimize Sampling Design |
|--|---|---|--|--|--|--|
| The groundwater beneath NASA JPL has been found to contain elevated concentrations of perchlorate, carbon tetrachloride, and other VOCs. Based on these elevated concentrations, an on-facility target treatment zone has been identified. | Reduce contribution to off-facility groundwater by reducing chemical concentrations in on-facility groundwater. | The primary type of information that needs to be obtained in order to resolve the decision statement is laboratory analyses of groundwater and soil samples collected from wells set in drilled boreholes. Groundwater and soil samples will be analyzed for perchlorate, carbon tetrachloride, and several other VOCs. | An 8-acre by 100-feet-thick portion of the site, identified as the target treatment zone, contains over 68% of the dissolved ClO_4^- mass. This represents less than 3% of the volume of groundwater with ClO_4^- concentrations greater than 10 $\mu\text{g/L}$. There are no temporal boundaries for the OU-1 source area treatment system. | Provide evidence that chemical concentrations and aerial extent of perchlorate and carbon tetrachloride in groundwater within the uppermost water-bearing zone are decreasing. In addition, provide evidence that the groundwater sampling produces representative data that achieves monitoring objectives and supports project management decisions. | Statistical performance parameters have not been determined because limits on decision error will not be considered. Data validation will be performed by an in-house review. | The proposed sampling locations are based upon those presented in the Work Plan. |

The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken. The analytical precision acceptability limits for this project will be:

- Water: 20% for all analyses
- Vapor: 20%
- Soil: 30%.

Laboratory accuracy refers to the percentage of a known amount of analyte recovered from a given matrix. Percent recoveries for groundwater and soil samples are estimated by Equation (B-2).

$$\text{Recovery (\%)} = \frac{(\text{Spiked Sample}) - (\text{Original Sample})}{(\text{Amount of Spike Added})} \times 100 \quad (\text{B-2})$$

The recovery of most spiked organic compounds is expected to fall within a range of 70 to 130%. The recovery of spiked metals should be between 75 and 125%.

Completeness refers to the percentage of valid data received from actual testing done in the laboratory. Completeness is calculated as shown in Equation (B-3). The target completeness goal for all compounds is 90%.

$$\text{Completeness} = \frac{\text{Number of Measurements Judged Valid}}{\text{Total Number of Measurements}} \times 100 \quad (\text{B-3})$$

1.7.3 Qualitative Objectives: Comparability and Representativeness

Comparability is the degree to which one data set can be compared to another. To ensure comparability, samples will be collected at specified intervals and in a similar manner, and will be analyzed within the required holding times by accepted methods. All data and units used in reporting this project will be consistent with accepted conventions for groundwater and soil analyses. This approach will ensure direct comparability between the results from this effort and the results from other projects using the methods presented in this SAP.

Representativeness is the degree to which a sample or group of samples is indicative of the population being studied. Over the course of this effort, samples will be collected in a manner such that they are representative of both the chemical composition and the physical state of the sample at the time of sampling.

1.8 Special Training/Certification (A8)

All personnel performing fieldwork must comply with Occupational Safety and Health Administration (OSHA) requirements as specified in 29 CFR 1910. Personnel will have current records of Hazardous Waste Operations and Emergency Response (HAZWOPER) training and subsequent 8-hour refresher training. At least one person on the field team will be trained in first aid and certified in cardiopulmonary resuscitation (CPR).

Field team members will be adequately trained in field methods and sampling procedures outlined in this plan. Specifically, field team members will have training in the following field activities: drilling and well installation; well inspection; groundwater sampling; use of water-level indicators, peristaltic and submersible pumps, and related field equipment; sample handling, packaging, and shipping; and handling of investigation-derived waste (IDW). The Project Manager will maintain training records for all field personnel as part of the project file. Training records demonstrating compliance with OSHA requirements as specified above will be kept on site at all times.

1.9 Documentation and Records (A9)

The following general types of documents and records will be maintained for this project:

- SAP
- Well construction diagrams
- Project logbooks
- Sample chain-of-custody forms
- General project correspondence
- Laboratory data reports
- Sampling and analysis reports.

The Project Manager is responsible for maintaining the above records to meet the requirements of this SAP. This requirement includes the maintenance of all records and data necessary for QA reports to management, corrective actions, and other associated documentation. Project documentation will be maintained for a minimum of five years following completion of the project.

2.0 FIELD SAMPLING PLAN (DATA GENERATION AND ACQUISITION)

The following sections describe the field activities that will be performed as part of the Expanded Demonstration System interim action at NASA JPL. These activities include surveying to mark the proposed extraction well and injection well locations and the underground piping route. In addition, all well locations and elevations will be resurveyed after installation in order to assist in the determination of the water table elevations within the target treatment area. Subsequent activities will then include collection of groundwater-level elevations and groundwater and soil samples. Collection of these samples is necessary to evaluate the soil and groundwater source zone and the impact the remedial activities have on the concentrations and extent of perchlorate and carbon tetrachloride in groundwater. For the operation and maintenance (O&M) of the Source Area Treatment System, collection of water samples for field and laboratory analysis is necessary for system performance and compliance monitoring and system optimization.

2.1 Sampling Process Design (Experimental Design) (B1)

The proposed field activities and the rationale for their design are discussed in detail in the Work Plan.

2.2 Sampling and Analytical Requirements (B2)

The SAP has been prepared to ensure that the DQOs specified for this project are met; the field sampling protocols are implemented, documented, and reviewed in a consistent manner; and the data collected are scientifically valid and defensible. This section addresses the sampling and analytical requirements.

2.2.1 *Extraction and Injection Well Installation*

The extraction well (EW-03) and injection well (IW-03) will each consist of a 6-inch diameter low carbon steel casing spanning from 0 ft to 215 ft bgs with a 100 ft screened interval that spans from 215 to 315 ft bgs, as described in Section 4.0 of the Work Plan. The depth to the water table is approximately 210 ft below ground surface (bgs) in the target area. However, it can vary by up to 60 ft due to seasonal variations. The wells will be screened entirely in the upper 100 ft of the saturated zone, which extends to approximately 900 ft above mean sea level (amsl). Groundwater samples will be collected from groundwater extracted from EW-03 and from groundwater reinjected into IW-03.

2.2.2 *Groundwater Sampling Procedures*

Groundwater sampling and analysis will be conducted for existing wells (i.e., MW-7, MW-8, MW-11, MW-13, MW-16, and MW-24) comprising the groundwater monitoring network (refer to Section 4.4 of the Work Plan), injection wells, and the extraction wells in accordance with the protocol described in this SAP. Groundwater chemical analyses will be performed by a California Department of Health Services (DHS)-certified laboratory using approved methods. Ambient air quality will be monitored and noted throughout field activities, including groundwater sampling.

2.2.2.1 Groundwater-Level Measurement Procedures

Groundwater-level measurements will be taken from each well before purging and just prior to sampling. The following procedure will be used to obtain groundwater-level measurements:

- The water-level probe will be decontaminated as described in Section 2.2.4.
- The probe will be lowered slowly until the instrument alarm and light response indicate that the water surface has been encountered. The measurement will be taken from the surveyed point on the well's protective enclosure. A straight-edge bar will be placed across the scribed marks on the protector, and the water level will be measured to the bottom of the bar from a point directly in the center of the well casing or the access tube.
- The measurement will be checked by slowly raising and lowering the tape and watching the instrument response. The measurement will be recorded in the field logbook.

2.2.2.2 Well Purging and Sampling Procedures

As the well cover is removed, the air in the breathing zone will be monitored with a flame ionization detector (FID), or equivalent, to ensure that escaping volatile organic compounds (VOCs) do not pose an adverse health effect to the field sampling team. The instrument will be calibrated in accordance with the manufacturer's requirements. Calibration data will be recorded in the instrument use log.

2.2.2.2.1 Traditional Purging and Sampling

A peristaltic or submersible pump will be used to purge the well. Teflon™-lined polyethylene tubing that has been decontaminated in accordance with Section 2.2.5 of this SAP will be used to purge and sample each well. The intake will be raised and lowered through the water column to remove stagnant water. The outlet of the well will be routed to a flow through cell to measure field parameters. The effluent groundwater will be transferred into a container of known volume to monitor the amount of water purged from the well. The water level in the well will be observed with the water-level indicator and recorded on the purge log.

Well purging to "dryness" will be avoided if possible. The well purging procedure for fast recharging wells (recovery 80% or more of static condition within 2 hours) is as follows (San Diego County Department of Environmental Health [DEH], 2002):

1. Remove one borehole volume of water. A borehole volume will be calculated using Equation (B-4):

$$BV = \left(\frac{7.48\pi}{4} \right) [CD^2 + P(BD^2 - CD^2)](WD - GW) \quad (B-4)$$

where

| | | |
|----|---|---------------------------|
| BV | = | borehole volume (gallons) |
| CD | = | casing diameter (feet) |
| P | = | porosity (0.30) |
| BD | = | borehole diameter (feet) |

WD = well depth (feet)
GW = depth to groundwater (feet).

2. Conduct field water quality measurements (temperature, pH, salinity, conductivity, dissolved oxygen (DO), and oxidation-reduction potential [ORP]). The handheld meters used to collect these measurements will be cleaned and calibrated in accordance with the operation manual. Standard Methods for the Examination of Water and Wastewater and U.S. EPA Methods will be used to supplement operation manuals when making these measurements. Calibration data will be recorded daily.
3. Remove an additional one-half borehole volume of water. Conduct field water quality measurements again. If the first and second measurements of temperature, pH, and conductivity vary by less than 10 percent, purging is considered to be adequate and proceed to Step 5.
4. Repeat Step 3 until the measurements for temperature, pH, and conductivity vary by less than 10% or until three borehole volumes of water have been removed. When these criteria are met, a statement will be made in the logbook documenting that the criteria have been satisfied.
5. Allow well to recover to 80% of its static condition prior to collecting the sample.

If purging to “dryness” is unavoidable, the purging procedure for slow recharging (recovery of 80% of the static condition is not achieved within two hours) wells will be used. The slow recharge purging procedure is as follows (San Diego County DEH, 2002):

1. Remove one borehole volume of water.
2. Collect a sample no later than two hours after purging, or as soon as enough water is present to sample. Note that if the well recovers to greater than 80% in less than two hours, use the procedure above.

All purge water and water used to decontaminate the field equipment will be contained in 55-gallon drums or polyethylene tanks. The water will be relocated to an appropriate storage area.

2.2.2.2.2 Micropurging and Sampling

When appropriate, wells will be micropurged, which involves pumping at much lower rates than traditional purging methods. The objective of micropurging is to minimize stress to the groundwater system by decreasing drawdown caused by pumping. Pumping at a low flowrate effectively isolates the screened interval from the overlying (stagnant) casing water, thereby sampling water from the screened interval only. Typically, flowrates on the order of 0.1 to 0.5 L/min are used during micropurging.

Water will be purged from the well until field measurements of pH, temperature, DO, ORP, specific conductivity, and turbidity stabilize. Purge procedures and stabilization guidelines are covered in Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (Puls and Barcelona, 1996). A peristaltic or submersible pump will be used to purge each monitoring well. Teflon™ fluorinated ethylene polymer (FEP) or similar tubing will be decontaminated in accordance with Section 2.2.6 and used for purging each well. Dedicated tubing will not require decontamination prior to use. The outflow of the well pump tubing will be routed to a flowthrough cell to measure field parameters. The effluent groundwater will then be transferred into a container of known volume to monitor the amount of water

purged from the well. The water level in the well will be observed during the purging process (if possible) with the water-level indicator.

2.2.2.3 Procedures for Sampling Wells Using a Peristaltic Pump

After the criteria for well purging have been met, the well can be sampled using a peristaltic pump, as outlined below:

- Sampling personnel will put on a new pair of disposable, powder-free, nitrile surgical gloves immediately before collecting samples at each location.
- To obtain a groundwater sample, the Teflon™-lined polyethylene tubing outlet will be disconnected from the flow through cell, and the corresponding sample containers will be carefully filled.
- The volatile organic analysis (VOA) vials will be filled through the sampling tube, taking care to reduce the flow until a meniscus is formed at the top of the vial. Each vial then will be preserved with two drops of hydrochloric acid (HCl), provided by the analytical laboratory, to reduce the pH to less than 2. The vial then will be capped and turned upside down to check for bubbles. If bubbles are present, the sample will be discarded and another vial will be filled, preserved, and checked for bubbles.
- Samples will be placed in ice chests or a refrigerator and maintained at approximately 4°C until shipment for analyses.

2.2.2.4 Procedures for Sampling Wells Using a Bailer

After the criteria for well purging have been met, the well can be sampled using a disposable Teflon™ bailer, as outlined below:

1. Sampling personnel will put on a new pair of disposable, powder-free, nitrile surgical gloves immediately before collecting samples at each location.
2. To obtain a groundwater sample, a disposable Teflon™ bailer will be lowered into the water slowly to prevent aeration. VOA containers will be filled first. After the bailer is retrieved from the well, a disposable Teflon™ sampling tube will be inserted in the top end of the bailer. Approximately 50 mL of water will be allowed to run through the tube before the VOA vials are filled. The VOA vials will be filled through the sampling tube, taking care to reduce the flow until a meniscus is formed at the top of the vial. Each vial then will be preserved with two drops of HCl, provided by the analytical laboratory, to reduce the pH to less than 2. The vial then will be capped and turned upside down to check for bubbles. If bubbles are present, the sample will be discarded; another vial will be filled, preserved, and checked for bubbles.
3. Samples will be placed in ice chests or a refrigerator and maintained at approximately 4°C until shipment for analyses.

2.2.2.5 *Groundwater Samples for Field Measurement of Water Quality Parameters*

Field measurements of water quality parameters will be measured. They include:

- pH
- DO
- Temperature
- Conductivity
- ORP
- Perchlorate (optional)
- Nitrate (optional)
- Sulfide (optional)
- Total organic carbon (optional).

2.2.2.6 *Groundwater Samples for Laboratory Analysis*

The groundwater will be analyzed for:

- Perchlorate
- Inorganic ions
- Sulfide
- Nitrogen
- VOCs
- Metals
- Alkalinity
- Total dissolved solids
- Total suspended solids
- Turbidity
- Biochemical oxygen demand
- Chemical oxygen demand.

2.2.3 *Soil Sampling Procedures*

A few select soil samples will be collected and then analyzed for perchlorate according to EPA Method 314.0. This analytical method provides a method detection limit (MDL) of 11 µg/kg and a practical quantitation limit of 50 µg/kg. Soil samples will be collected at depths where no prior soil samples have been collected during previous site assessment investigations.

Soil samples will be collected from the vadose zone and/or capillary fringe during well installation activities at selected depths and locations. Soil sampling will be conducted as follows:

1. The split-spoon sampler, continuous core barrel, and all associated sampling equipment will be decontaminated using the decontamination procedures for field equipment described in Section 2.2.4.
2. After reaching the desired depth, a 2.6-inch-I.D., 18-inch-long split-spoon sampler containing stainless steel sleeves will be driven into the soil.
3. The sampler will be retrieved from the borehole, and one-half of the split-spoon will be removed so that the soil recovered in the sleeves rests in the remaining half of the barrel.
4. The sleeve to be used for laboratory analysis will be removed from the lower end of the split-spoon sampler. Each end of the sleeve will be capped with a Teflon™ sheet, sealed with a polyethylene lid, and labeled.
5. All soil samples will be immediately sealed in a plastic bag and placed in an ice chest or a refrigerator, where they will be maintained at approximately 4°C until shipment for analyses.
6. All remaining soil samples will be disposed of with the soil cuttings.

2.2.4 System Monitoring

This section presents the sampling and analysis requirements for the various components of the remediation system. The number of samples and types of field and laboratory analyses for system monitoring are summarized in Table B-2. Groundwater samples will be collected at three points along the GAC portion of the system. Samples will be collected at the inlet, the midpoint, and the outlet sections of the GAC. Similarly, the inlet and the outlet of the FBR will be sampled. One sample will be collected from the multimedia filter outlet. Table B-3 provides the reporting limits for the analytical methods used for groundwater.

2.2.5 Decontamination Procedures

All nondisposable field equipment will be decontaminated as described below before each use to avoid cross-contamination between samples and to ensure the health and safety of the field crews

Commercially available distilled (DI) water and reagent-grade methanol will be used as intermediate rinses. The final rinse will use high-performance liquid chromatography (HPLC)-grade water (or equivalent). The following sequence will be used to clean all field equipment and sampling devices:

- Wash the samplers with Liquinox™ detergent and DI water and clean them with a stiff-bristle brush.
- Rinse with DI water.
- Rinse with methanol.
- Rinse with HPLC-grade water (or equivalent).
- Place the sampling equipment on a clean surface and air dry.

2.2.6 Disposal of Contaminated Materials

Several waste streams will result from the execution of this SAP. Wastes will be periodically sampled and analyzed for the organic and inorganic constituents noted in Table B-2 so that the ultimate disposal method for the wastes can be identified. NASA will be responsible for the ultimate disposal of both hazardous and non-hazardous wastes. A description of each waste stream is presented below.

Table B-2. Summary of Monitoring Parameters and Analytical Method

| Constituent | Units | Analytical Method | Method Number | Method Detection Limit | Reporting Limit |
|---------------------------------------|-------|-------------------|---------------|------------------------|-----------------|
| <i>Soil</i> | | | | | |
| Perchlorate | µg/g | IC | 314.0 | 11 | 50 |
| <i>Groundwater</i> | | | | | |
| Perchlorate | µg/L | IC | 314.0 | 1 | 2 |
| Chlorate | mg/L | IC | 300.0 | 0.05 | 0.1 |
| Chloride | mg/L | IC | 300.0 | 0.01 | 0.2 |
| Bromide | mg/L | IC | 300.0 | 0.2 | 0.5 |
| Nitrate-Nitrogen (NO ₃ -N) | mg/L | IC | 300.0 | 0.01 | 0.1 |
| Nitrite-Nitrogen (NO ₂ -N) | mg/L | IC | 300.0 | 0.01 | 0.1 |
| Orthophosphate | mg/L | IC | 300.0 | 0.02 | 0.5 |
| Sulfate | mg/L | IC | 300.0 | 0.07 | 0.5 |
| Sulfide | mg/L | Titrimetric | 376.1 | 0.4 | 1 |
| Nitrogen | mg/L | Colorimetric | 351.2 | 0.2 | 1 |
| Carbon tetrachloride | µg/L | GC/MS | 8260B | 0.2 | 1 |
| 1,1-Dichloroethene | µg/L | GC/MS | 8260B | 0.2 | 1 |
| 1,2-Dichloroethane | µg/L | GC/MS | 8260B | 0.2 | 1 |
| Tetrachloroethene | µg/L | GC/MS | 8260B | 0.2 | 1 |
| Trichloroethene | µg/L | GC/MS | 8260B | 0.2 | 1 |
| 1,4-Dioxane | µg/L | MS (SIM) | 8270C Mod | 0.5 | 2 |
| Arsenic | µg/L | ICP | 6010B | 0.037 | 0.1 |
| Trivalent chromium | µg/L | ICP | 6010B | 0.006 | 0.02 |
| Hexavalent chromium | µg/L | IC | 7199 | 0.1 | 0.2 |
| Alkalinity | mg/L | Titrimetric | 310.1 | 0.1 | 1 |
| Total dissolved solids | mg/L | NA | 160.1 | 4 | 10 |
| Total suspended solids | mg/L | NA | 160.2 | 4 | 10 |
| Turbidity | NTU | Nephelometric | 180.1 | NA | 10 |
| Biochemical oxygen demand | mg/L | NA | 405.1 | 1 | 2 |
| Chemical oxygen demand | mg/L | Colorimetric | 410.4 | 5 | 10 |

Table B-3. Sampling and Analytical Requirements for Investigation Derived Waste ^(a)

| Waste Type | Sampling/Analysis Frequency | Analysis |
|------------------------|------------------------------------|---|
| Drill cuttings | As containers are filled | Perchlorate, organics and metals listed in Table B-2, pesticides, and PCBs. |
| Purge water from wells | As containers are filled | Perchlorate, organics, and metals listed in Table B-2. |

(a) All analyses to be performed at an off-site laboratory.

2.2.6.1 Soils

Soils associated with sampling operations have the potential of containing some level of perchlorate. Soil cuttings and any residual materials associated with sampling activities will be stored temporarily in approved containers, prior to transportation and disposal at an off-site licensed facility. Analytical results characterizing the contents of each storage container will be obtained to determine whether the materials will require disposal in either a hazardous or non-hazardous facility. Copies of the manifests for all containers of soil removed from the project site will be retained in the project files.

2.2.6.2 Groundwater and Decontamination Wastewater

Groundwater from well purging activities and any decontamination water generated during field sampling efforts will be stored temporarily in approved containers. Analytical results from the streams that constituted the wastewater will be obtained prior to transportation of the water off-site.

2.2.6.3 Used Personal Protective Equipment

The field activities will be performed in Level D personal protective equipment (PPE) and/or modified Level D PPE. Used PPE (if applicable) will be stored temporarily in 55-gallon drums prior to transportation and disposal at an off-site licensed facility.

2.2.6.4 Waste Transport, Disposal, and/or Treatment

Loading and transporting soil, groundwater/decontamination water, and used PPE (if applicable) will be coordinated with a specified NASA representative. Original copies of the manifest and disposal notification forms will be provided to the transporter for shipment. Copies of waste manifests and receipts for the disposal of wastes will be retained.

2.3 Sample Handling and Custody (B3)

This section presents sample handling and custody procedures for the remediation activities. These procedures will ensure proper handling, custody, and documentation of the samples from field collection through laboratory analyses.

2.3.1 Sample Handling

Groundwater samples are to be collected and containerized in order of decreasing volatility of parameters. The preferred collection order for groundwater samples is:

1. VOCs
2. perchlorate, nitrates, etc.
3. metals.

Additional sample collection and handling considerations associated with the fieldwork for this project include:

- Measurements of temperature, pH, specific conductivity, DO, salinity, and ORP will be made in the field prior to groundwater sample collection.
- A sufficient sample volume will be collected from each location sampled to serve the needs of all analyses (including matrix spikes, matrix spike duplicates, and field duplicates).
- All samples to be analyzed for volatile compounds will be collected and capped with zero headspace. Sample containers will have a special cap fitted with a Teflon™-lined septum, and will be filled to full and securely capped. The sample containers will be inverted, shaken, tapped, and visually inspected for air bubbles by the sample team prior to leaving the sample site. If air bubbles are observed, the entire sample collection process will be repeated.
- Sample containers for water samples will be filled to approximately 90% capacity, except for sample containers that will be analyzed for volatile compounds.

2.3.2 Sample Containers, Holding Times, and Preservation and Turnaround Times

Table B-4 presents sample container, holding time, and preservation requirements for the listed analytical parameters based on U.S. EPA SW-846 requirements. New, pre-cleaned sample containers will be used. The laboratory selected to receive the samples will supply containers.

Once collected, each containerized sample will be labeled and placed into a matrix-specific sample cooler. The sample cooler will serve as the shipping container and will be provided by the laboratory with the sample containers. The sample cooler will be packed with ice to cool samples to 4°C during shipment. Samples are to be transported to the laboratory promptly in order to provide ample time for analyses to be conducted within the established maximum holding times. The maximum interval between sample collection and shipment is to be one business day.

The Project Manager or designee is responsible for coordinating with the laboratory for sample shipment via laboratory pick-up or overnight delivery service. U.S. Department of Transportation (DOT) regulations concerning the shipment of environmental samples to a laboratory for analysis will be followed.

2.3.3 *Sample Packaging and Shipping*

Immediately after samples are collected and labeled for off-site laboratory analysis, they will be placed in a matrix-specific ice chest or cooler. The samples will be packed with shock-absorbent materials, such as bubble wrap, to prevent movement or breakage of the sample jars during transport. The ice chest will be filled with wet ice in order to meet the 4°C preservative requirement. A temperature blank will accompany each cooler.

The chain-of-custody will be placed in a zip-lock bag and taped to the inside of the cooler. The ice chest will be banded with packaging tape and custody seals will be placed along the ice chest lid in order to prevent or indicate tampering. The cooler containing the environmental samples will be picked up by the laboratory or arrangements can be made to have the cooler delivered to the laboratory by an overnight delivery service such as Federal Express. If an overnight delivery service is used, the package must be scheduled for priority overnight service so that the temperature preservative requirement is not exceeded.

Table B-4. Sample Containers, Holding Times, and Preservation Methods for Soil and Groundwater Samples

| Constituent | Method Number | Sample Container | Preservation Method | Max. Holding Times |
|---------------------------|---------------|-------------------------|--|--------------------|
| <i>Soil</i> | | | | |
| Perchlorate | 314.0 | 4 oz | Cool, 4°C | 28 days |
| <i>Groundwater</i> | | | | |
| Perchlorate | 314.0 | 125-mL amber or plastic | Cool, 4°C | 28 days |
| Chlorate | 300 | 50-mL poly | Cool, 4°C | 28 days |
| Chloride | 300 | 50-mL poly | Cool, 4°C | 28 days |
| Bromide | 300 | 50-mL poly | Cool, 4°C | 28 days |
| Nitrate | 300 | 50-mL poly | Cool, 4°C | 48 hours |
| Nitrite | 300 | 50-mL poly | Cool, 4°C | 48 hours |
| Orthophosphate | 300 | 100-mL poly | Cool, 4°C | 48 hours |
| Sulfate | 300 | 50-mL poly | Cool, 4°C | 28 days |
| Sulfide | 376.1 | 500-mL glass | Cool, 4°C, ZnAc, NaOH, pH>9 | 7 days |
| Nitrogen | 351.2 | 500-mL poly | Cool, 4°C, H ₂ SO ₄ , pH<2 | 28 days |
| VOCs | 8260B | 3 x 40-mL glass | Cool, 4°C, No headspace, pH<2 HCl | 14 days |
| 1,4-Dioxane | 8270C Mod | 1,000-mL amber glass | Cool, 4°C | 7 days |
| Total metals | 6010B | 250-mL poly | Cool, 4°C | 180 days |
| Hexavalent chromium | 7199 | 100-mL poly | Cool, 4°C | 24 hours |
| Alkalinity | 310.1 | 200-mL poly | Cool, 4°C | 14 days |
| Total dissolved solids | 160.1 | 500-mL poly | Cool, 4°C | 7 days |
| Total suspended solids | 160.2 | 500-mL poly | Cool, 4°C | 7 days |
| Turbidity | 180.1 | 100-mL poly | Cool, 4°C | 48 hours |
| Biochemical oxygen demand | 405.1 | 1,000-mL | Cool, 4°C | 48 hours |
| Chemical oxygen demand | 410.4 | 100-mL plastic | Cool, 4°C, H ₂ SO ₄ , pH<2 | 28 days |

2.3.4 Sample Documentation

Sample documentation includes sample designation, sample labeling, field notes, and chain-of-custody forms. Sample designation provides that each sample will be uniquely identified, labeled, and documented in the field at the time of collection. Each sample container will have a sample label affixed to the outside of the container in an obvious location. Example labels are presented in Figures B-2 and B-3. Information will be recorded on the label with water-resistant ink. The sample label will specify:

- Sample identification number
- Date and time of sample
- Preservation used
- Analytical methods
- Project name.

| |
|-----------------------------------|
| Client/Project Name: _____ |
| Sample ID: _____ |
| Date/Time: _____ |
| Analysis: _____ |
| Preservative: _____ |
| Samplers Name: _____ |

Figure B-2. Sample Label for Water Samples

| |
|---|
| Client Name: _____ |
| Sample ID: _____ |
| Date/Time: _____ |
| Analysis: _____ |
| Samplers Name: _____ |
| Sample Type: Grab Composite Other |

Figure B-3. Sample Label for Soil Samples

The field notebook will be used to provide daily records of significant events, observations, and measurements during field investigations. The field logbook also will be used to document all sampling activities. All notebook entries will be made with indelible ink to provide a permanent record. Logbooks will be kept in the possession of the field technician during the on-site work and all members of the field team will have access to the notebook. These notebooks will be maintained as permanent records.

The field notebooks are intended to provide sufficient data and observations to reconstruct events that occurred during installation and sampling. All notebooks will be given a unique label and multiple notebooks will be assigned serial numbers. The following items will be recorded in the field logbook.

- Name, date, and time of entry
- Names and responsibilities of field crew members
- Name and titles of any site visitors
- Descriptions of drilling and sampling procedures, and problems encountered
- Number and amount of samples taken at each location
- Details of sampling location
- Identification numbers of all samples collected
- Date and time of collection
- Sample collection method
- Decontamination procedures
- Field measurements (e.g., DO, ORP, temperature, pH, and conductivity) and general observations.

Each sample container is to be logged using a chain-of-custody form prior to shipment or pickup by the laboratory. The chain-of-custody form will be signed by the individual responsible for custody of the sample containers and will accompany the samples to the laboratory. A sample chain-of-custody form is presented in Figure B-4. Information to be recorded on the chain-of-custody form should include:

- Sample matrix
- Sample collector's name
- Dates/times of sample collection
- Sample identification numbers
- Number and type of containers for each sample aliquot
- Type of preservation
- QC sample designation
- Analysis method
- Special handling instructions
- Destination of samples
- Name, date, time, and signature of each individual releasing the shipping container.

CHAIN OF CUSTODY

| | | | | | | | | | | | | | | | |
|---|--------|---|------|----------------------------|------------------------------|-------------------|------|--------------------|--|----------|---------------|---|--|----------|--|
| EMAX Laboratories, Inc. | | 1835 W. 205th Street, Torrance, CA 90501 Tel #: 310-618-8889 Fax #: 310-618-0818 Email: info@emaxlabs.com | | | PO NUMBER: SAMPLE STORAGE | | | EMAX CONTROL NO. * | | | PROJECT CODE: | | | | |
| CLIENT | | | | MATRIX CODE | | PRESERVATIVE CODE | | ANALYSIS REQUIRED | | | | TAT | | | |
| PROJECT | | | | DW=Drinking Water | | IC=Ice | | | | | | <input type="checkbox"/> Rush ____ hrs. | | | |
| COORDINATOR | | | | GW=Ground Water | | HC=HCl | | | | | | <input type="checkbox"/> Rush ____ days | | | |
| TEL FAX EMAIL | | | | WW=Waste Water | | FN=HNO3 | | | | | | <input type="checkbox"/> 7 days | | | |
| SEND REPORT TO | | | | SD=Solid Waste SL=Sludge | | SH=NaOH | | | | | | <input type="checkbox"/> 14 days | | | |
| COMPANY | | | | SS=Soil Sediment | | ST=Na2S2O3 | | | | | | <input type="checkbox"/> 21 days | | | |
| ADDRESS | | | | WP=Wipes FP=Paint Products | | ZA=Zinc Acetate | | | | | | <input type="checkbox"/> 30 days | | | |
| EMAX PM | | | | AR=Air | | HS=H2SO4 | | | | | | <input type="checkbox"/> ____ days | | | |
| | | | | O= | | | | | | | | <input type="checkbox"/> | | | |
| SAMPLE ID | | SAMPLING | | | CONTAINER | | | MATRIX CODE | | QC | | PRESERVATIVE CODE | | COMMENTS | |
| LAB | CLIENT | LOCATION | DATE | TIME | NO. | SIZE | TYPE | | | | | | | | |
| * 1 | | | | | | | | | | | | | | | |
| * 2 | | | | | | | | | | | | | | | |
| * 3 | | | | | | | | | | | | | | | |
| * 4 | | | | | | | | | | | | | | | |
| * 5 | | | | | | | | | | | | | | | |
| * 6 | | | | | | | | | | | | | | | |
| * 7 | | | | | | | | | | | | | | | |
| * 8 | | | | | | | | | | | | | | | |
| * 9 | | | | | | | | | | | | | | | |
| * 0 | | | | | | | | | | | | | | | |
| Instructions | | | | | | | | | | Cooler # | Temp. (°C) | Sample #s | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| SAMPLER | | | | | COURIER/AIRBILL | | | | | | | | | | |
| RELINQUISHED BY | | | Date | Time | RECEIVED BY | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| <small>NOTICE: Turn-around-time (TAT) for samples shall not begin until all discrepancies have been resolved. For samples received and discrepancies resolved after 1500 hrs, TAT shall start at 0800 hrs the next business day. The client is responsible for all cost associated with sample disposal. Samples shall be disposed of as soon as practical (but not prior to fifteen (15) calendar days) after issuance of analytical report unless a different sample disposal schedule is pre-arranged with EMAX. Disposal fee for samples defined by CA Title 22 as non-hazardous shall be \$5.00 per sample. EMAX will return hazardous samples to the client at the client's expense unless directed in writing otherwise.</small> | | | | | | | | | | | | | | | |

Figure B-4. Sample Chain of Custody for Water and Soil Samples

The laboratory will designate a sample custodian. This individual is responsible for inspecting and verifying the correctness of the chain-of-custody records upon sample receipt. The sample custodian will accept the samples by signing the chain-of-custody form and noting the condition of the samples in writing on the chain-of-custody or other receipt form. The sample custodian will notify the Project Team Leader of any discrepancies.

Samples received by the laboratory will be entered into a sample management system, which must include:

- Laboratory sample number
- Field sample designation
- Analytical batch numbers
- List of analyses requested for each sample container.

Immediately after receipt, the samples will be stored in an appropriate secure storage area. The analytical laboratory will maintain written records showing the chronology of sample handling during the analysis process by various individuals at the laboratory.

2.4 Analytical Methods (B4)

This section presents minimum criteria for laboratory selection and discusses methods to be used for analyses of soil, groundwater, and investigation-derived waste samples.

2.4.1 Laboratory Selection

An analytical laboratory that has successfully completed the Navy evaluation process through the Naval Facilities Engineering Service Center (NFESC) will perform all analyses, unless otherwise specified by NASA. Aqueous and soil samples for this task order will be analyzed by a California-certified laboratory.

Battelle's Project Manager will communicate sampling and analysis schedules to the laboratory with sufficient lead-time to meet contractual agreements with the laboratory.

2.4.2 Laboratory Analytical Methods

Laboratory analytical methods were selected based on the project DQOs and in consideration of the method detection limits achievable for each parameter. Each laboratory analytical method was chosen to address the intended use of the sampling data. Table B-2 shows the laboratory analytical methods that are to be used during the field activities.

2.4.3 Quantitative Reporting Limits

Factors that influence the quantitative reporting limits of analytical methods include the analytical method itself, sample matrix interference, and high concentrations of the target analyte. Actual reporting limits may vary from sample to sample in accordance with standard laboratory practices. Table B-2 provides the reporting limits for the analytical methods used for the soil and groundwater.

2.5 Quality Control Requirements (B5)

QA can be described as an integrated system of activities in the area of quality planning, assessment, and improvement to provide the project with a measurable assurance that the established standards of quality are met. QC checks, including both field and laboratory, are the specific operational techniques and activities used to fulfill the QA requirements.

2.5.1 Field Quality Control Checks

Proper sample acquisition and handling procedures are necessary to ensure the integrity of the analytical results. All procedures will be followed in both the field and the laboratory. The collection frequency for each QC sample is listed in Table B-5. The field QC samples will be assigned unique sample numbers and submitted to the analytical laboratory. If abnormalities are detected in field QC checks, the data associated with the QC checks will be flagged and appropriate actions will be taken to rectify issues.

Table B-5. QC Sampling Collection Frequency

| Type of Sample | Number of Samples |
|---|---|
| Field Duplicates | 10%; if <10 per day, one sample will be collected |
| Equipment Rinsate ^(a) | 1 per day |
| Trip Blank | 1 per cooler |
| Field Blank | 1 per day |
| Laboratory Quality Assurance ^(b) | 5% |

(a) Required to verify decontamination between samples where non-dedicated equipment is used.

(b) For MS/MSD analyses.

2.5.1.1 Field Duplicate Samples

Field duplicate samples will be collected at a rate of 10% of the total number of samples during a sampling event. If fewer than 10 samples are collected, one duplicate sample will be collected. For all water samples, duplicate samples will be collected by retaining consecutive samples from the sample pump.

2.5.1.2 Equipment Rinsate Blanks

Equipment rinsate blanks will be collected daily to ensure that non-dedicated sampling devices (i.e., Teflon™-lined polyethylene tubing) have been decontaminated effectively. Equipment rinsate blanks will consist of the final HPLC-grade (or equivalent) rinsewater used in the final step of the sampling equipment decontamination procedure. Rinsate samples will be collected at a frequency of one per day during sampling events. The rinsate QA samples for the split-spoon samplers used to collect soil samples will be obtained prior to collection of the samples by rinsing through the decontaminated split-spoon sampler containing sleeves with HPLC-grade water (or equivalent). The water will be collected in a 40-mL VOA vial and returned to the laboratory for analysis. A peristaltic or submersible pump with Teflon™-lined polyethylene tubing will be used to collect the groundwater samples. The rinsate samples will be collected following decontamination of the tubing and prior to collection of the groundwater samples. The rinsate blanks will be collected by rinsing through the decontaminated tubing with HPLC-grade water. The water will be collected in 40-mL VOA vials and returned to the laboratory for analysis. Equipment rinsate blanks will be analyzed for VOCs only.

2.5.1.3 Trip Blanks

Trip blank samples will accompany each cooler that contains samples being submitted for volatile parameter analysis. Trip blanks will be prepared at the laboratory by filling 40-mL VOA vials with HPLC-grade water. Trip blanks are not to be opened in the field.

2.5.1.4 Field Blanks

Field blanks for groundwater sampling will be collected daily and will consist of three 40-mL VOA vials. The vials will be filled with HPLC-grade water prior to collection of a groundwater sample, and the uncapped vials will be placed upwind of the well during collection of the groundwater sample. Following groundwater sample collection, the vials will be acidified, capped, labeled, and recorded in the field logbook. The purpose of this type of blank is to detect possible contamination of the sample from airborne hydrocarbons during sample collection.

2.5.2 Laboratory Quality Control Checks

Laboratory QC is addressed through the analysis of laboratory QC samples, documented internal and external laboratory QC practices, and laboratory audits. Three types of laboratory QC samples will be used in this project: laboratory blank samples, MS/MSD samples, and laboratory control spikes (LCSs). Definitions of each type of laboratory QC sample are listed below. Analytical results for these samples will become the quantitative focus of the laboratory QC activities. For laboratory measurements, if any of the QC checks are outside the acceptance criteria, corrective actions will be taken. The laboratory QC checks, acceptance criteria, and corrective actions are listed in Table B-6.

Table B-6. Quality Control, Acceptance Criteria, and Corrective Action

| QC Sample Type | Acceptance Criteria | Corrective Action |
|-------------------|--|---|
| Procedural blank | $<5 \times \text{MDL}$ | Results examined by analyst. Corrective action (re-extraction, reanalysis) or justification document. |
| Blank spike | 80-120% | |
| Calibration | 5-point calibration curve ($\text{RSD} \leq \pm 20\%$); mid-range NIST standard solution ($\text{RSD} \leq \pm 20\%$) (Battelle SOP, Appendix H) | Investigate the problem, resolve the problem, and recalibrate. |
| Calibration check | Mid-range calibration solution ($\text{RSD} \leq \pm 30\%$) (every 10 samples) | Investigate the problem, resolve the problem, recalibrate, and re-analyze affected samples. |

MDL = Minimum detection limit is estimated from the lowest calibration standard solution. Samples below the MDL will be reported as not detected (ND).

RSD = relative standard deviation.

Laboratory blank samples are designed to detect contamination of routine samples that occurs in the laboratory. Laboratory blanks verify that method interference caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Laboratory blanks are deionized water for aqueous samples. A minimum of one laboratory blank will be analyzed each day that routine samples are analyzed. The concentration of the target compounds in the laboratory blank sample must be less than or equal to the reporting limit. If the blank is not under the specified limit, the source contamination is to be identified and corrective actions taken.

MS and MSD samples are designed to check the precision and accuracy of the analytical methods through the analysis of a normal sample with a known amount of analyte added. Additional sample volume for MS and MSD samples will be collected in the field in the same manner as field duplicate samples. In the laboratory, two portions of the sample are spiked with a standard solution of target analytes. MS and MSD samples will be analyzed for the same parameters as the routine samples, and analytical results will be evaluated for precision and accuracy of the analytical method and effects of the sample matrix. The MS and MSD samples will be collected from 5% of all routine samples.

Laboratory control samples include blank spikes and blank spike duplicates. Blank spike samples are designed to check the accuracy of the analytical method by measuring a known concentration of an analyte in the blank spike samples. Blank spike duplicate samples are designed to check the accuracy and precision of the analytical method by measuring a known concentration of an analyte in the blank spike duplicate sample. Blank spike and blank spike duplicate samples are prepared by the laboratory using clean laboratory matrices spiked with the same spiking compounds used for matrix spikes at levels approximately 10 times greater than the method detection limit.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance (B6)

Various field instruments will be used during the field activities. Such instrumentation may include a water quality meter for measuring pH, DO, specific conductivity, ORP, and temperature; water level indicator for measuring water levels in wells; and an FID for measuring VOCs in breathing zones. A list of field instruments that will be used for during the remediation activities at NASA JPL is provided in Table B-7.

Table B-7. Field Meters

| Matrix | Parameter | Instrument |
|---------------------|--|---|
| Groundwater | Water quality parameters (DO/ORP/temperature/conductivity/ pH) | Horiba U-22/Horiba U-10 |
| Groundwater | Groundwater-level | Electric water level indicator or oil/water interface probe |
| Groundwater | Various (perchlorate, nitrate, sulfide, TOC) | Ion selective electrodes |
| Soil/Breathing Zone | Organic vapors | Photovac FID or equivalent |

Field instrument maintenance will be documented in the field logbook for each field instrument used during field activities. Field equipment will be maintained when routine inspections indicate the need for maintenance. In the event that a piece of equipment needs repair, a list of the field equipment manufacturers' addresses, telephone numbers, and points of contact will be maintained on site during field activities. Field equipment routine maintenance may include the following:

- Calibrating equipment according to manufacturer directions
- Removing surface dirt and debris
- Replacing/cleaning filters when needed
- Ensuring proper storage of equipment
- Inspecting instruments prior to use
- Charging battery packs when not in use
- Maintaining spare and replacement parts in field to minimize downtime.

Laboratory instrument maintenance, including standard preventive maintenance procedures and schedules, will be performed in accordance with the method documentation.

2.7 Instrument/Equipment Calibration and Frequency (B7)

Methods for calibrating field instruments will follow the specific instrument manufacturers' recommendations. All field instruments will be calibrated before each day of use; and a calibration check at the end of the day will be performed to verify that the instrument remained in good working condition throughout the day. If the calibration check at the end of the day does not meet acceptance criteria, then that day's data will be flagged and the instrument calibration checks will increase to the operator's satisfaction that the instrument remains true to the initial calibration.

Laboratory instrument calibration will be performed as specified in the method documentation. Specific laboratory calibration techniques are established for the U.S. EPA methods to demonstrate that the analytical instrument is operating within the design specifications and that the quality of the data generated can be replicated.

2.8 Inspection/Acceptance Requirements for Supplies and Consumables (B8)

Any supplies and consumables used in the sample collection process or instrument calibration, such as sample bottles, pump tubing, deionized water, calibration gases, etc., will be inspected upon receipt and prior to use. The sample tubing should also come with a certificate of acceptance. At a minimum, the Project Manager or a field team member will inspect the tubing upon receipt for damage or broken seals.

2.9 Non-direct Measurements/Data Acquisition Requirements (B9)

Non-direct measurement data are not anticipated as part of the field implementation or field decision-making aspects of this project.

2.10 Data Management (B10)

The purpose of the data management section of this SAP is to briefly describe the procedures that will be used to maintain data quality throughout the project. These operations include, but may not be limited to, data recording, data reduction, and data reporting.

2.10.1 Data Recording

All field observations and laboratory results will be linked to a unique sample location through the use of the sample identification system. Field observations and measurement data will be recorded on the field forms and in a field notebook to provide a permanent record of field activities. All data that are hand-entered will be subjected to a review by a second person to minimize data entry errors. A check for completeness of field records (logbooks, field forms, databases, electronic spreadsheets) will ensure that all requirements for field activities have been fulfilled, complete records exist for each activity, and the procedures specified in this SAP have been implemented. Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event.

2.10.2 *Data Reduction*

The data will be reviewed by the contractor to determine if the qualitative parameters of representativeness and comparability have been achieved. In general, the review will be accomplished by comparing the chain-of-custody and field notebook entries with the data for the sample. If the reported concentrations of a field sample from a specific location do not reflect historical data, then efforts will be made to determine if the data reflect an actual change in environmental conditions at that sampling point, or if the integrity of the sample was compromised during collection, preservation, shipping, or analysis. Conversely, if some level of analyte historically present in samples from a specific location is no longer present, then similar efforts will be made to confirm that change in concentration. QA/QC requirements that bracket questionable data again will be reviewed to confirm the performance of instrumentation during the time when questionable data were generated. Any deviations will be documented, and corrective actions will be taken to determine if the data meet project goals. If the data do not meet project goals, then the need for additional sampling and analysis will be determined.

2.10.3 *Data Reporting*

Following the data review process, the sample results will be entered into an electronic database. This electronic database will be submitted to NASA in a format compatible with the Naval Electronic Data Deliverable (NEDD). Data will be compiled with spatial and temporal qualifiers so that it will be possible to rapidly plot or review changes in the concentrations of target analytes at each sampling point over time. Hard copies of the data reports received from the laboratories will be filed chronologically in three-ringed binders and will be stored separately from the electronic files. Hard copies of data signed by a representative of the analytical laboratory will be compared to any electronic versions of the data to confirm that the conversion process has not modified the reported results. Any additional reporting formats will be completed, and electronic and hard copies will be stored in different locations at the contractor's facilities.

3.0 ASSESSMENT AND OVERSIGHT

This section describes the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the SAP is implemented, as prescribed.

3.1 Assessment and Response Actions (C1)

Assessments that may be performed during continued site assessment activities at NASA JPL include, but are not limited to, the following: technical system audits, audits of data quality, and data quality assessments.

3.1.1 Performance and System Audits

Technical systems audits and audits of data quality may be conducted periodically during site assessment activities by the Battelle QAO at the request of the Battelle Project Manager. In addition, the Battelle Project Manager/QAO will conduct regular audits of the field and laboratory data as they are generated as well as data/sample collection procedures. This schedule of QA checks will require the cooperation of the laboratory regarding timely delivery of reports. However, it will ensure that data quality issues are identified early, rather than at the end of the investigation.

If significant variances are found during the audit, the Battelle QAO may conduct additional audits. Additional audits may include a visit to the field and to the laboratory, if required and if determined to be necessary by the Battelle Project Manager. The Battelle QAO will review the SAP.

For those audits resulting in variances, the Project Team Leader or the laboratory coordinator will submit a response in writing to the Battelle QAO. Reports will be submitted to NASA through the RPM.

3.1.2 Corrective Action

Corrective actions may be initiated by any of the participants of the data generation (field technician or laboratory analyst), reporting (laboratory director or field team leader), and validation process (Battelle Project Manager or QAO). Note that it is important to generate corrective actions early in the process so that the problem has a greater chance of being resolved in a timely and cost-effective manner. An example Corrective Action Report is presented in Figure B-5.

For field measurements, if the final calibration check is outside acceptable limits, then the associated data collected that day will be flagged. On the following day, a single point continuing calibration check will be run after every five wells monitored (or samples analyzed) to determine how long the initial calibration holds. Calibration frequencies will be adjusted accordingly.

For laboratory measurements, if any of the QC checks (MS, MSD, laboratory control samples, or laboratory blank) are outside the acceptance criteria (for accuracy, precision, and cross-contamination), the laboratory will follow the corrective actions that are outlined in the Laboratory Quality Assurance Plan (LQAP).

3.2 Reports to Management (C2)

Project reports prepared by Battelle will be submitted to NASA through the RPM. The schedule and additional recipient list for submission of these reports following completion of remedial activities will be decided accordingly.

| CORRECTIVE ACTION REPORT | |
|--|--------------------------------|
| SECTION A: STATEMENT OF PROBLEM (TO BE COMPLETED BY INITIATOR) | |
| (a) Item of nonconformance: | (b) Number: |
| (c) Location of nonconforming item: | (d) Date: |
| (e) Name, organization, and telephone number of person initiating NCR | (f) Date nonconformance found: |
| (g) Individual/organization responsible for the resolution of the nonconformance: | |
| (h) Reference: | |
| (i) Description of nonconformance: (1) identification of nonconforming item or service; (2) requirements, including the specific reference documented by title, revision, and its unique identification number; and (3) as found conditions: | |
| (j) Signature of initiator: | Date: |
| (k) QA Manager concurrence: | Date: |
| (l) STOP WORK order required YES NO | |

Figure B-5. Sample Corrective Action Report

| | |
|--|-------|
| SECTION B: PROBLEM RESOLUTION (TO BE COMPLETED BY THE RESPONSIBLE INDIVIDUAL/ORGANIZATION) | |
| (a) Responsible individual/organization: | |
| (b) Proposed resolution: | |
| (c) Root cause: | |
| (d) Actions taken to prevent recurrence: | |
| Responsible individual: | Date: |

Figure B-5. Sample Corrective Action Report (continued)

4.0 DATA VALIDATION AND USABILITY

This section is divided into three elements that describe the QA activities that occur after the data collection phase of the project has been completed to ensure that data conform to the specified criteria and thus satisfy monitoring objectives.

4.1 Data Review and Verification (D1)

The data generated for this project will be reviewed by the Battelle QAO and verified by either an independent outside review or in-house review.

4.2 Verification Methods (D2)

The data verification and reporting process for the field data involves ensuring that calibration of instruments, field blanks, and field duplicates are within the acceptance criteria. The verification process for the laboratory data involves ensuring that hold times, precision, accuracy, laboratory blanks, and detection limits are within the acceptance criteria outlined in this SAP.

The field and laboratory personnel will provide the Battelle Project Manager with all the data. The Battelle Project Manager or designee then will send the laboratory data either to an outside independent review company or to in-house review for data verification. The Battelle QAO will be responsible for overall review of the data verification results, for compliance with the specified DQOs. After this QA procedure is complete, the Battelle Project Manager will incorporate the verified data into final reports.

4.3 Reconciliation With Data Quality Objectives (D3)

Data collected during the field efforts will be reconciled with the DQOs by preparing summary tables, charts, figures, or performing other types of data analyses that facilitate direct comparison of data collected during the baseline through the entire extent of the project. Comparisons will be made on a parameter-specific basis, concentrating on the contaminants of concern. Comparisons also will facilitate an analysis of contaminant concentration trends through time and space.

5.0 REFERENCES

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